Document No. WG-335

# FAA NOTICE OF PROPOSED RULEMAKING (NPRM)

and

# JAA NOTICE OF PROPOSED AMENDMENT (NPA)

applicable to: -FAR Part 29 Transport Category Rotorcraft
-JAR 29 Large Rotorcraft

## SYSTEM LIGHTNING PROTECTION

Produced by Electromagnetic Effects Harmonization Working Group (EEHWG)

Date: 20 Nov. 1998

[4910-13]

DEPARTMENT OF TRANSPORTATION

**Federal Aviation Administration**

**14 CFR Part 29**

**[Docket No. ; Notice No. ]**

**RIN 2120-**

**Airworthiness Standards; System Lightning Protection**

**AGENCY:** Federal Aviation Administration, DOT.

**ACTION:** Notice of proposed rulemaking (NPRM).

**SUMMARY:** This amendment revises lightning protection certification standards for electrical and electronic systems installed in Transport Category Rotorcraft. The accepted means of assessing and classifying the criticality of systems and equipment, as well as the related terminology, have changed since the original rule was promulgated. This regulation is being revised to reflect those changes while preserving the original intent.

**DATES:** Comments must be received on or before **[INSERT DATE 120 DAYS AFTER OF PUBLICATION IN THE FEDERAL REGISTER.]**

**ADDRESSES:** Comments on this notice may be delivered or mailed, in triplicate, to: Federal Aviation Administration, Office of the Chief Counsel, Attn: Rules Docket (AGC-200), Docket No., Room 915G, 800 Independence Avenue, SW., Washington, DC 20591. Comments submitted must be marked: "Docket No. ." Comments may also be sent electronically to the following internet

address: nprmcmts@mail.hq.faa.gov. Comments may be examined in Room 915G on weekdays, except Federal holidays, between 8:30 a.m. and 5:00 p.m.

**FOR FURTHER INFORMATION CONTACT:.**

**SUPPLEMENTARY INFORMATION:**

**Comments Invited**

Interested persons are invited to participate in the making of the proposed rule by submitting such written data, views, or arguments as they may desire. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this notice are also invited. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket or notice number and be submitted in triplicate to the Rules Docket address specified above.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel on this rulemaking, will be filed in the docket. The docket is available for public inspection before and after the comment closing date.

All comments received on or before the closing date will be considered by the Administrator before taking action on this proposed rulemaking. Late-filed comments will be considered to the extent practicable. The proposals contained in this notice may be changed in light of the comments received.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this notice must include a pre-addressed, stamped postcard with those comments on which the following statement is made:

"Comments to Docket No.." The postcard will be date stamped and mailed to the commenter.

## Availability of NPRM

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the FedWorld electronic bulletin board service (telephone: 703-321-3339), the FEDERAL REGISTER's electronic bulletin board service (telephone: 202-512-1661), or the FAA's Aviation Rulemaking Advisory Committee Bulletin Board service (telephone: 202-267-5948).

Internet users may reach the FAA's web page at http://www.faa.gov or the FEDERAL REGISTER's webpage at http://www.access.gpo.gov/su_docs for access to recently published rulemaking documents.

Any person may obtain a copy of this NPRM by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267-9680. Communications must identify the notice number or docket number of this NPRM.

Persons interested in being placed on the mailing list for future NPRM's should request from the above office a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, that describes the application procedure.

## Background

### Statement of the Problem

The concern for the vulnerability of rotorcraft electronic systems to the effects of lightning has increased substantially over the past few years. . Fundamentally,

this concern is a result of greater reliance on such systems to provide functions whose failure may prevent the continued safe flight and landing of the aircraft. Also, the use of solid-state components in the design of electronic control systems in rotorcraft has made such systems potentially susceptible to transient effects of induced electrical current and voltage caused by a direct lightning strike to the rotorcraft. These induced transient currents and voltages can degrade electronic system performance by damaging components or upsetting system functions. Component damage means a permanently altered electrical characteristic that can include dielectric breakdowns and effects from heat in semiconductor junctions, resistors, and component interconnections. Functional upset refers to an impairment of system operation, either permanent or momentary (e.g., a change of digital or analog state), that includes logic changes in computer and processing systems, electronic engine and flight controls, and power generating and distribution systems.

Another factor that has contributed to this increased concern is the reduced electromagnetic shielding afforded rotorcraft electronic systems by advanced technology rotorcraft materials.

The accepted means of assessing and classifying the criticality of systems and equipment has been continuously evolving and maturing (e.g. SAE ARP4754/EUROCAE ED-79, SAE ARP4761, AC 25.1309-1A, AC 23.1309-1B, AC 29-2A Paragraph f(2) Change 3, RTCA DO-178/EUROCAE ED-12, etc.). The earlier classification concept of failure conditions as either "Critical," "Essential," or "Non-Essential" functions was fundamental to the wording of the

original rule and the associated Advisory Circular, AC/AMJ 20-136, Protection of Aircraft Electrical/Electronic Systems against the Indirect Effects of Lightning. For a number of reasons, this classification concept has given way to the perspective that systems and equipment failure conditions can have "Catastrophic," "Hazardous/Severe-Major," "Major," or "Minor" effects on rotorcraft safety. The revision herein proposed is intended to render this lightning protection regulation compatible and consistent with the latest classification concepts, terminology, and practices, such as the certification levels that are related to the classification of the failure conditions, with the focus on functions rather than systems.

Since trends indicate that future aircraft designs will incorporate similar systems, the cognizant aviation certification authorities have determined that a change in the design standards of 14 CFR part 29 and JAR 29 is necessary.

There are three sections in FAR/JAR part 29 that specifically pertain to lightning protection, one for the rotorcraft in general (§ 29.610), one for the fuel system (§ 29.954) and the third for electrical and electronic systems (§ 29.1309). Section 29.610 now requires the rotorcraft structure to be protected from the effects of lightning. This regulation states that compliance can be shown either by bonding components to the rotorcraft or by designing components so that a strike will not endanger the rotorcraft. Section 29.954 now requires the rotorcraft fuel system to be protected from the effects of lightning. The emphasis of § 29.954 is on the external aspects of lightning protection and the occurrence of catastrophic accidents directly attributed to lightning-related fuel vapor ignition.

Section 29.1309(h) requires, when showing compliance with paragraphs (a) and (b) of this section, the effects of lightning strikes on the rotorcraft must be considered. This section is being retained, as this requirement focuses attention to the need to assess the effects of lightning when carrying out the Functional Hazard Assessment (FHA).

## Discussion of the Proposals

### Section-by-Section Discussion of the Proposals

Section 29.1316 System Lightning Protection

A new section, 29.1316, would be added by this proposal to address lightning protection for electrical and electronic systems, equipment, and installations. Since lightning protection for electrical and electronic systems is a significant, certification effort, these requirements should be separated from section 29.1309 and expanded in a separate section.

Safety Analysis

A means of compliance as defined in AC/AMJ 20-136A would use established development assurance levels for electrical and electronic systems, which are related to the classification of the functional failure conditions. The functional failure condition classification would be assessed by performing a Functional Hazard Assessment (FHA) during the certification process and would be approved by the FAA/JAA. An FHA is conducted to identify all failures and classify them in functional and operational terms.

The results of the FHA should be reviewed to ensure that any unique indirect effects of lightning have been identified, such as common mode failures. It should also be noted that functional failure condition classifications are originally assessed and established by the FHA early in the certification process. It is therefore possible that unforeseen conditions may be identified during subsequent phases of the safety assessment process, which may result in a change to some of these classifications.

Airworthiness requirements for classifying these functions are based on AC/AMJ 25.1309-1A, System Design Analysis, which provides guidance in classifying these functional failure condition classifications according to their severity. The functional failure condition classifications listed are derived from this guidance material and are included to assist in the use of this document. The classifications are:

Classifications

(a) Catastrophic: Failure conditions that would prevent the continued safe flight and landing of the rotorcraft.

(b) Hazardous/Severe-Major: Failure conditions that would reduce the capability of the rotorcraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be:

(1) A large reduction in safety margins or functional capabilities,

(2) Physical distress or higher workload such that the flight crew could not be relied on to perform their tasks accurately or completely, or

(3) Serious (or fatal)@ injury to a relatively small number of the occupants.

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(c) Major. Failure conditions that would reduce the capability of the rotorcraft or the ability of the crew to cope with adverse operating conditions to the extent that

there would be, for example, a significant reduction in safety margins or functional capabilities, a significant increase in crew workload or in conditions impairing crew efficiency, or discomfort to occupants, possibly including injuries.

(d) Minor. Failure conditions that would not significantly reduce rotorcraft safety, and that involve crew actions well within their capabilities. Minor failure conditions may include, for example, a slight reduction in safety margins or functional capabilities, a slight increase in crew workload such as routine flight plan changes, or some inconvenience to occupants.

(e) No Effect. Failure conditions that do not affect the operational capability of the rotorcraft or increase crew workload.

Development assurance levels are related to the functional failure condition classification and are assigned to systems according to the following:.

Development Assurance Levels

(a) Level A: Electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in a catastrophic failure condition for the rotorcraft.

(b) Level B: Electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in a hazardous/severe-major failure condition for the rotorcraft.

(c) Level C: Electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in a major failure condition for the rotorcraft.

(d) Level D: Electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in a minor failure condition for the rotorcraft. Once a system has been confirmed, by the cognizant aviation

certification authority, as being level D, no further application of this regulation is required.

(e) Level E: Electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in no effect on rotorcraft operational capability or crew workload. Once a system has been confirmed, by the cognizant aviation certification authority, as being level E, no further application of this regulation is required.

A summary of the requirements is presented in Table 1, Compliance Summary.

Level A Requirements

Functions performed by electrical and electronic systems whose failure to provide that function correctly could lead to a catastrophic failure condition, would require protection to the extent that the function must not be adversely affected when the rotorcraft is exposed to lightning. These functions must continue to be provided during and after the time the rotorcraft is exposed to lightning.

If the function is provided by multiple systems, then loss of one or more systems, during exposure of the rotorcraft to lightning, shall not result in the loss of the function. After the rotorcraft is exposed to lightning, each affected system that performs these functions shall automatically recover normal operation, unless this conflicts with other operational or functional requirements of that system. Any failure or malfunction which occurs during the qualification process must be considered in the overall safety assessment as required by section 29.1309.

Level B and C Requirements

Functions performed by electrical and electronic system(s) whose failure could cause a hazardous/severe-major or major effect would require protection from

the indirect effects of lightning to the extent that, when the equipment of which the system(s) is/are comprised, is exposed to the lightning threat or equivalent test level, the electrical and electronics systems that perform the functions must not be damaged and the functions must be recoverable in a timely manner. The equivalent test level is defined in AC/AMJ 20-136A, Certification of aircraft Electrical/Electronic Systems for the Indirects Effects of Lightning.

Compliance

To demonstrate compliance with the proposed requirements, an applicant should show that the requirements outlined in Table 1, Compliance Summary, are met for each electrical and electronic system whose failure to function may produce failure conditions ranging from catastrophic to major.
Acceptable operation during exposure to system or equipment level tests may be shown using analysis, modeling, testing, and/or similarity methods as agreed to by the FAA/JAA.

Deviations from the performance specifications of systems under consideration may be acceptable. These deviations would need to be assessed to demonstrate that the effects of the deviations neither cause nor contribute to conditions that would adversely affect rotorcraft operational capabilities. When deviations in performance occur as a consequence of system or equipment

exposure to a test level, an assessment of the acceptability of the performance should be made. This assessment should be supported by analysis and data.

Compliance Criteria for Level A Systems

Compliance of systems classified as Level A will be demonstrated by test and/or analysis. This may be considered adequate, when:

(a) The functions performed by these systems are not adversely affected during and after the period of a system level test, when the systems are exposed to a test level determined for the rotorcraft installation in accordance with the method defined in AC/AMJ 20-136A.

AND

(b) Each affected system that performs such a function must automatically recover normal operation following aircraft exposure to the lightning environment unless this conflicts with other operational or functional requirements of that system.

AND

(c) Any system interruption should be evaluated to assure continued performance of the aircraft function and should be approved by the FAA/JAA)

Compliance Criteria for Level B and C Systems

Compliance of systems classified as Level B or C will be demonstrated by equipment test and/or analysis. Test levels are defined in AC/AMJ 20-136A. The systems must not be damaged and the functions must be recoverable in a

timely manner after exposure to the lightning threat or equivalent test level as defined in AC/AMJ 20-136A.

As an alternative for demonstrating compliance to lightning protection for Level B and Level C systems, Rotorcraft Flight Manual limitations may be applied for aircraft that are limited to VFR flight conditions. For aircraft that are limited to VFR flight conditions, the aviation certification authority may accept the probability of exposure and/or loss of Level B and Level C functions with a Rotorcraft Flight Manual restriction, providing that an acceptable level of safety for the type of rotorcraft and its operation can be demonstrated. The Type Certificate Data Sheet , Rotorcraft Flight Manual (RFM), supplemental RFM, and/or placard should contain the statement as follows: "This aircraft is only approved for VFR flight conditions and must not be operated into known or forecast lightning conditions."

Compliance by Similarity

As an alternative to the test methods described in the preceding paragraphs for the approval of electrical and electronic systems whose failure may produce failure conditions ranging from catastrophic, hazardous/severe-major to major, an applicant may submit previously approved data for consideration by the FAA/JAA in determining compliance with the proposed requirements. Guidance for compliance by similarity is provided in AC/AMJ 20-136A. Certification by similarity is not applicable for a combination of new aircraft design and new equipment design.

TABLE I

COMPLIANCE SUMMARY

| DEVELOPMENT ASSURANCE LEVEL | COMPLIANCE REQUIREMENTS |
|---|---|
| LEVEL A | 1. Function must not be adversely affected during and after exposure to the lightning threat as defined in AC/AMJ 20-136A.<br>2. Any system interruption should be evaluated to assure continued performance of the rotorcraft function and should be approved by the FAA/JAA.<br>3. Affected systems must automatically recover upon removal of the lightning threat, unless this conflicts with other operational or functional requirements of that system. |
| LEVEL B or C | 1. Functions must be recovered in a timely manner after exposure to the lightning threat or equivalent test level as defined in AC/AMJ 20-136A. |

**Paperwork Reduction Act**

In accordance with the Paperwork Reduction Act of 1980 (Pub. L. 96-511), there are no requirements for information collection associated with this proposed rule.

## International Compatibility

The FAA has reviewed corresponding International Civil Aviation Organization regulations and Joint Airworthiness Authority regulations and has identified no differences in these proposed amendments and the foreign regulations.

## Regulatory Evaluation Summary

**[TO BE DEVELOPED BY APO]**

## Initial Regulatory Flexibility Determination

**[TO BE DEVELOPED BY APO]**

## International Trade Impact Analysis

**[TO BE DEVELOPED BY APO]**

## Federalism Implications

**[DEPENDS UPON APO ECONOMIC ANALYSIS]**

## Conclusion

**[First paragraph depends on APO economic analysis]**

The FAA proposes to add a new section to provide lightning standards for Transport Category Rotorcraft and to harmonize them with the standards that have been proposed by the Joint Aviation Authorities in Europe. If adopted, the

proposed section would create uniform standards for the protection of electrical and electronic systems, equipment, and installations for these Rotorcraft.

**List of Subjects in 14 CFR Part 29**

Air Transportation, Aircraft, Aviation Safety, Rotorcraft, Safety

**The Proposed Amendment**

Accordingly, the FAA proposes to amend part 29 of Title 14, Code of Federal Regulations (14 CFR part 29) as follows:

**PART 29--Airworthiness Standards: Transport Category Rotorcraft**

1. The authority citation for part 29 continues to read as follows:

**Authority**: 49 USC 106(g), 40113, 44701, 44702, 44704

2. A new Section 29.1316 is added to read as follows:

**§ 29.1316 System Lightning Protection**

Rotorcraft electrical and electronic systems, equipment, and installations considered separately and in relation to other systems must be designed and installed according to the following:

(a.) Each function, the failure of which would prevent the continued safe flight and landing of the rotorcraft--

(1) Must not be adversely affected during and after exposure of the rotorcraft to the lightning environment; and

(2) Each affected system that performs such a function must automatically recover normal operation following rotorcraft exposure to the lightning

environment unless this conflicts with other operational or functional requirements of that system.

(b) Each system that performs a function, the failure of which would cause large reductions in the capability of the rotorcraft or the ability of the crew to cope with adverse operation conditions, may not be damaged and must be recoverable in a timely manner after exposure to the lightning environment.

(c) Each system that performs a function, the failure of which would reduce the capability of the rotorcraft or the ability of the crew to cope with adverse operation conditions, may not be damaged and must be recoverable in a timely manner after exposure to the lightning environment.

Issued in Washington, DC, on